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THE STUDY OF STATISTICS.

In view of the widespread interest in the essay presented to our Association at the May meeting, 1887, by Hon. Carroll D. Wright, on *Statistics in Colleges*, no apology is needed for the subject of the present paper. For its treatment, however, there is asked your indulgent consideration. I have no special claim either from study or experience, as has the honored Chief of the National Department of Labor. All that I propose to attempt is an outline of a possible course in Statistics, suitable for colleges or institutions of similar rank. I shall not seek to justify the wisdom or expediency of establishing such courses; I take it for granted that educational authorities are already impressed with this; that the words of Mr. Wright have been accepted in the spirit with which they were tendered; and that there is no need of reviewing ground already so well covered. On the other hand there is perhaps opportunity and assistance to be rendered by counselling as to the actual methods to be pursued, when once it has been decided to introduce this study.

Here is a specific study, new on this side of the Atlantic as a study, its merits vouched for by men eminent in their treatment of social and economic questions, but apparently with no home, history, or interpreter to a people unacquainted with its objects and principles. Its languages are foreign to us; this alien does not even hail from our mother-country, England, but has been reared in Germany, France, or Italy. It is not surprising, therefore, that

there is perplexity as to the best method of naturalizing the educational immigrant. Let us first describe the character and scope of this foreign science, taking for example the well-known volume of Haushofer as a representative of the body of knowledge, which in Germany is included under the term *Statistik*.

This is substantially as follows: There is, first, a preliminary statement of the history and theory of Statistics and of statistical inquiry; a treatment of population statistics, including its present state as to sex and age; its enumeration or the census; its movement by birth, death, and migration; economic statistics, including a survey of production, distribution and consumption, thus embracing the statistics of agriculture, mining, forestry, manufactures, price, transportation and trade; social and political statistics, noting the distribution of population in city and country, with the growth of cities; the statistics of marriage and divorce, of governmental administration and budgets, of schools, education, and justice; *moral Statistik*, a term not so easily translated, but best understood in its explanation,—embracing the statistics of crime, with its varied relations to age, sex, nationality, occupation, education, or religious belief; also of suicide, and of such social cancers as prostitution; and, finally, the statistics of literature, art, and religion.

An exhaustive treatment of this nature is nothing more nor less than an examination of human life in its various forms by the application of statistical measurements. It is statistics applied to human biology, to political economy, sociology, political science, public and private law. In short, it is encyclopedic in its aims, and requires for its proper pros-

ecution, not only a considerable mental training, but also a solid fund of information as a preliminary basis.¹

To my mind, therefore, such a course can be profitably pursued only in a post-graduate department or by collegiate students who have studied advanced courses in social and political science. For the college, therefore, which does not undertake the work of post-graduate instruction there is, as it seems to me, no fitting place for the complete and finished study of Statistics, except it be included in the rank of options or electives open to students of special attainments. This conclusion, however, does not rule out all possible instruction in Statistics in educational institutions of a purely collegiate grade; and the special object of this paper is to offer something, if possible, to the solution of this problem.

The study of Statistics is valuable for two reasons: first, for the information it imparts; and secondly, for the discipline it provides. It is in this latter object that the chief advantage of the study is to be derived in undergraduate courses; and I am persuaded that the study of Statistics should be regarded for

¹*Geschichte, Theorie, und Technik der Statistik*, by August Meitzen (1886), is even more advanced and critical in its treatment, and at the same time more compact. On the other hand it deals but slightly with the results of statistical investigation as far as these may furnish illustrative material for Social Science, but is devoted rather to the theoretical and technical aspects of the subject.

Traité théorique et pratique de Statistique, by Maurice Block (2d ed. 1886), resembles in its treatment the work of Haushofer rather than that of Meitzen. What is said above in regard to the encyclopedic character of European treatises would apply with full force to that of Block.

the most part simply as a laboratory exercise, to be used in connection with other courses; just as the chemical laboratory is designed to fix more firmly in the student's mind the principles and the science of chemistry, and thus make real forces which would otherwise be but myths of a text-book; or as the dissecting-room discloses secrets in anatomy which no volume or series of illustrated plates, even though interpreted by the rarest pedagogical genius, can reveal. So the study of Statistics can be most profitably combined with courses on Commerce, Industry, Finance or other subjects of economic history. The principle then of this instruction should not be independent of, but subordinate to, other branches.

Take, for example, a course in the financial history of the United States, which involves the treatment of the revenues and expenditures of our government as well as the progress of the national debt. The student will undoubtedly gain a far more lasting knowledge of the subject matter if he pursue a collateral or laboratory course in Statistics which is based upon the Finance Reports. Let him trace the evolution of the Finance Report from its humble beginning; note the gradual increase in the number of the statistical tables from table A to table W, and their significance and value in affording information both to officials and to the general public. If the student be required to do nothing more than to prove the column of figures as to the amount of the public debt given, for example, in the American Almanac, from the Finance Reports themselves, he will have been taught a valuable lesson; he will know where to go in case of dispute; he will have acquired some delicacy in reconciling discrepancies, and he will gain

independence in sharing in the same tools and weapons of the most eminent scholar.¹

It may be objected that this requires time; undoubtedly, but not so much as is oftentimes imagined, for the extra effort given in this direction certainly shortens the time demanded for reading or study of lecture notes on account of their more easy apprehension.

The methods now followed in chemistry regard two hours of laboratory practice as none too many for every lecture attended; the student simply performs experiments which are fully described in the text, and which he may indeed see performed by the instructor in the presence of his class; and yet there is no question in the minds of instructors of chemistry that the lesson is but half learned, unless the student himself carries the experiment through independently and unaided. It is not expected that the student will make new discoveries or add anything in the line of fresh investigation. From two to three years at the very least, must be spent in the chemical laboratory before a student can expect to win new prizes for his chosen science. Even granting that the student is not studying chemistry as a specialist, but only for the one term or year commonly granted to it in our colleges, the experimental work is still regarded as imperative.

Again, consider the application of such laboratory work in Statistics to the tariff history of the United States, a study which Prof. Taussig has shown can

¹The five finance volumes of the American State Papers, covering the period 1789—1828, is a good practice-ground for this purpose. They are rich in statistical material, which is unarranged and not summarized

be made as valuable, both from the standpoint of informing political culture and also of discipline, as any elementary or even advanced subject in applied economics. In this, the study of Statistics should be made the very backbone of the course. There are few studies which are of more value in leading the student to mental habits of exactness, precision, thorough investigation, caution, and even humility, if that be possible, than this study of our tariff history, combined with a strong infusion of Statistics. Such a course should secure some acquaintance with the Commerce and Navigation Reports issued since 1821, with the scattering reports in the American State Papers previous to that date, with the Reports of the Special Commissioner of Revenue for the years immediately succeeding 1864, with Evans' Report, and others of like nature. Acquainted with the use of these, the student is in a position to hunt down some of the numerous statistical errors which vitiate not only the arguments of a political campaign, based upon economic issues, but also more serious articles in the daily and the magazine press. It should be the honest and intelligent aim of colleges and their students to check the current dishonest uses of statistical material for political bewilderment.¹

In connection with a course on the history of industry, advantageous use can be made of the Reports of the Bureau of Statistics of Labor, when the student, for example, may once for all be impressed, as Prof. Smith has pointed out, with the vicious misapplication of "the average;" can learn with most tell-

¹ A fresh example of the irresponsible use of Statistics is furnished at the present moment of writing, April, 1889, in the campaign in progress in Massachusetts for constitutional prohibition.

ing emphasis, which should outwear any amount of political sophistication in after life, the difference between real and nominal wages; and will be led to regard with wholesome suspicion many of the statistical arguments so freely advanced at the present time, as to the relative condition of laborers,—for with some of these reports it may be proved with almost equal facility that the laborer has gone forward or backward, or has remained stationary in his position in life. There is no intention in this to educate the student to view these reports with contempt or cynicism; far from it, for some of these documents are of great value; but as long as the precious and the base pass current at equal rates, the student should be trained in discrimination and in the application of a sounder judgment.

In courses on civil government which should include not only a consideration of the practice of our national administration, but also municipal and town government, there is again a field for statistical exercises in budgets. I doubt if, in any other way, a class can be aroused to a keener appreciation of the problems of municipal government than by the study of the controller's reports of a large city for a series of ten or twenty years. In this connection the study of public accounts from the statistical standpoint is valuable. The attempt to determine the *real* city debt is a problem in point. In some of our cities the figures given indicate almost nothing as to the true financial situation. Why has the municipal debt increased? What proportions of the expenditure fall to the several departments? What relative change has there been in this? are other questions to be investigated.

The foregoing, then, is an outline of laboratory work in statistical practice, which I think can practically be incorporated into civic and economic courses of study. By this it will be observed that the student has gained an acquaintance with the Finance Reports, the Reports on Commerce and Navigation, the Reports of Bureaus of Labor and Municipal Finance Reports, and it will also be noted that some of this work can be easily connected with courses in American history and with courses of a more specific economic nature.

The next point to be considered is the *method* to be followed. There are three general ones which I would suggest: *first*, research and verification; *second*, tabulation; and *third*, graphic illustrations.

First, then, *research and verification*; in this the object of instruction is to lead the student to search for certain statistics, or to verify by authoritative documents figures which may be quoted in current literature. At first the range of statistical territory to be hunted over should be restricted to a narrow range. A practical illustration of this nature is, for example, calling for a verification of the figures given by Pitkin for imports down to 1815, by reference to the finance volumes in the American State papers. This method has been followed with great success by Prof. Hart, of Harvard University, in American statistics; and to him I am much indebted for students' work which has been loaned illustrating that method. A few of the subjects assigned are as follows:

1. State sources of information as to coinage of the United States mint, 1789-1887. This led the student to an examination of the reports of the directors of

the Mint, the Statistical Abstracts, Seybert's Statistical Annals.

2. A statement of the receipts of the United States, 1789-1886. This involved an examination of Gallatin's Report for 1810, for the period 1789-1809; of the Report of the Secretary of the Treasury for 1815, in which year it is noted that there is a difference of over \$300,000 in the statements of the report of the Secretary for that year, and the statement as given in the Finance Report for 1885; for the years 1815-1828, it is observed that the reports varied considerably in form; for the years 1860-1864, it is noted that there is a discrepancy which is found under the head, "Miscellaneous."

3. Another compared the statistics of direct taxes as given in the Statistical Abstract, the American Almanac, Pitkin's Statistical View, and the Finance Reports for the first thirty years of our national history, and reported that all agree in every figure, save a difference between the figures 2 and 3, in the year 1817.

Further exercises call for a statement of the salaries of the President and the Cabinet since the establishment of the government; expenditures for foreign missions; of the judiciary department; the contingent fund of the House; defalcations of officers; and so on in a great number.

Training of this nature makes the student alert, as well as careful and exact in his method of study. If to some these exercises appear insignificant, it may fairly be said, though, of course, it is not an answer but simply enlarges the field of controversy, that there is abundant analogy in the method followed in chemistry or physics. The laboratory exercises as-

signed at the outset in these sciences afterwards appear to the professional chemist or physicist as most simple, as doubtless do the statistical exercises which I have just presented.

Of the second method, *tabulation*, little needs to be said. It can be best employed in conjunction with the foregoing one. One example is, perhaps, sufficient. A class of nine is divided into committees of three, with instructions to report respectively on the production, imports, exports, and domestic consumption of iron, cotton, and wool in the United States in the colonial period, and to tabulate the results. Stress is laid upon the form of tabulation; and, generally, each committee will waste two or three schedules before they hit upon an accurate and compact form.

The third method is the use of *graphic illustration*. At the outset, let me say that I well recognize the danger that exists in frittering away the time of students in the execution of perfect or ornamental plates which belong rather to the department of drawing than to economic training. In exercises of this nature, it is not a question of securing work from the student, but of restraining him from devoting too much time to them. Pupils who shun pages of figures, as they would the hardest page of calculus, find in their graphical illustration a fascination which will play havoc with other portions of the curriculum. The work, if it be undertaken at all, must be carefully planned by the instructor, and constant watchfulness needs to be exercised that the task shall not exceed the ability and a reasonable amount of time of the student.

Let me illustrate my meaning by a practical ex-

ample. Suppose that the young student is studying the natural resources of our country; that you wish to impress upon him the territorial distribution of certain products, as, for example, iron; and that you wish to carry the investigation even to the county divisions of the several states. To ask the student to draw a map, outline the counties, and draw or paint a certain number of dots or circles within each county, which will correspond to the multiples of the unit in iron ore which you may have selected, say 25,000 tons produced in the several counties, is to assign a task out of all proportion to the advantage to be derived. If, however, you furnish an extensive outline map of the United States, such as that prepared under the direction of Prof. Hart, and show the student that he can locate the counties roughly by laying tissue paper over the map of an ordinary political county atlas, and with the census volume before him can easily make the mental calculation as to the proper number of units to allot to each county,—this number to be pencilled on the tissue sheet by the aid of an ordinary rubber die of a given diameter and an ink pad,—then he can, with great rapidity, lay out his map with fairly satisfactory results. By contrivances of this nature, the required time can be so minimized as to bring the work within reasonable limits.

Let it be distinctly understood that graphic exercises in statistics are used simply as a means for arousing the interest of the student in securing along the line of least resistance results which will be of lasting advantage in his educational development. To draw a curve of the national debt from 1789 until 1887 is an easy thing and may seem to some almost

childish; in the student of a junior class it may create inquiry which had never before been suggested, or but vaguely suggested, and prove to be a sufficient incentive for further investigation. Take, for instance, the following as an exercise: On page 19, of Professor Taussig's monograph, "Protection to Young Industries," there is a note with a table giving the imports, exports, exports of foreign produce, and the price of flour per barrel. There is a certain relation between these different sets of figures. The student reads the paragraph and discovers in a general way the truth stated in the text. Require the class, however, without any previous reference to this passage, to plot on the same chart curves representing these columns and one or two other series of statistics; and then to reason and explain the picture which is thus presented, and you have given them a double lesson, a lesson in logic, as well as in economic history. You have done much to induce the student to reason for himself.¹

¹With regard to chart paper for statistical illustration, my own experience may be of some value. As lithographed cross-section paper is too expensive for general purposes, I have had various sizes printed. At first the chart I adopted was 20 by 28 inches, ruled into tenths of inches—the tenth line being ruled more heavily. This gives 280 units for time and 200 for amount, etc. This did not prove to be a convenient subdivision to use for historical curves of the United States, when it was desired to cover the 100 years of our national history, for it is wise, if possible, to have the decade or half-decade year coincide with the heavy ruled line. The size is also in many cases objectionable, as being too large to place in the student's note-book. I have consequently had printed small sheets, 8 by 10 inches, ruled according to the metric system, the subdivision being 2 millimetres, with the fifth line heavier. This admits of 250 spaces for time and 200 for amount. I may add that on account of the fine ruling required it was necessary to have a special

In the use of graphic representation as one of the methods of laboratory work, it seems to me advisable also to make the art itself a series of progressive and educational exercises. That is, the student should have brought before his attention a variety of ways that may be used in illustration. These methods have been roughly divided by European statisticians into diagrams, distinguished as the dot or point, curved line, circular or closed axis ; surface figures, as the square, the circle, the isosceles triangle ; into cartograms which include maps with surface diagrams, maps colored according to territorial divisions, maps with curves, and maps in relief.¹ In the use, therefore, of graphic illustration, there is no need of confining the student to that form so generally used, the curved line ; but his range may be widened, until he learns the peculiar fitness that there is in each, the limitations of the various forms, and the defects to be avoided. The graphic method is more and more being used for popular illustration, and oftentimes grave misconceptions are the result.

Let the student learn, for example, that the isosceles triangle is preferable to the square or the circle in the representation of numerical ratios, where the increments are slight but nevertheless important, and that it is an unsafe method to follow if the increments are large, unless narrow bases are employed. He needs

set of pens made. At the same time I had large sheets of heavy brown paper ruled by centimetres (corresponding to the heavy fifth lines of the smaller sheet) in the largest size possible, 48 by 48 inches. These are serviceable for charts for class-room instruction.

¹These various methods I have described in detail in an article "Elementary Notes on Graphic Statistics," published in the *Technology Quarterly* (Boston), October, 1888.

also but a slight suggestion to perceive that comparison by means of an inner and an outer circle or square is most defective. A series of progressive exercises would include such tasks as these : first, the representation of two arbitrary numbers as 25 and 100 by half-a-dozen different methods. The student will probably hit upon the line, the circle with proportional areas, the circle with proportional sectors, two squares, or triangles with equal bases, etc. Let him be sharply questioned in regard to the respective merits of these for general illustration. A second exercise is the drawing of a curve of, say, the national debt, in which the increment used is small for the time, indicated by the line of abscissas, while the increment for the amount, denoted by the perpendicular line, is large ; require then the conditions to be reversed and the increment of time to be represented by a larger space and the increment of amount by a smaller ; and let the student note the force of the respective changes. A third exercise will comprise the drawing of a number of curves, in which the student will learn the use of colors or forms of lines to prevent confusion. A fourth, the representation of a total separated into its elementary parts ; as in the familiar way of illustrating the total receipts of our government, and at the same time indicating the various kinds. Here we have a series of superimposed parallelograms, and the student can be given a lesson in cross-hatching as well as in colors. A fifth exercise may be devoted to the preparation of a map in colors to represent, for example, the congressional vote of the different States on the establishment of the United States Bank, or of the production of cotton or the proportion of voters to the total population.

With five such fundamental exercises as these, the student is prepared to examine with considerable judgment the numerous statistical albums and atlases which are so frequently issued in these days, but which need to be used with caution, and should be preceded, if possible, by special training.

With this hasty sketch of the available material and the method to be followed, the subject has by no means been exhausted. Every instructor will quickly discover new methods as well as improve upon those already mentioned. My only apology for this unsatisfactory treatment of the subject is that, to me at least, it has largely been pioneer work in which there are confessedly many mistakes and steps to be retraced.

Before concluding let me add a suggestion in regard to the study of Statistics in its fullest conception,—the study which at the outset was relegated to post-graduate courses or to electives requiring more than the ordinary amount of economic instruction. Until recently there was no work in the English language upon this subject. Instructors who wished to establish such a course were forced to resort to Block or Haushofer. Now, however, our own Association has come to the rescue in the publication of Prof. Richmond M. Smith's admirable monograph on Statistics. The point which I wish to make is that from this as a starting point excursions can be profitably made into the field of American Statistics of an economic or sociological character. It is my impression that the abundance of fresh material here offered is not adequately recognized by scholars in general. Registration Reports, Health Reports, Insurance Reports, Reports of Boards of Charities and Correction and of

Prison Commissioners, are issued annually in many of our States. Many of these, to be sure, are undigested, poorly tabulated, and ill arranged, but yet contain detailed data which only await the industrious investigator with a sound judgment for the production of fruitful results. As it is they are little used, save by professional and trade papers; in their broader applications to social science they are neglected. Such material would be most richly prized by European statisticians and should not by our own scholars be allowed to accumulate unnoticed.

Even if nothing more were done than to secure a uniform presentation of data by the various bureaus of the several States or to awaken a more intelligent conception of the utility of Statistics on the part of officials who now perfunctorily fulfil the bare letter of the law, something would be accomplished.